

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 August 2003 (28.08.2003)

PCT

(10) International Publication Number  
**WO 03/071030 A1**

(51) International Patent Classification<sup>7</sup>: **D21F 7/08**

(21) International Application Number: **PCT/GB03/00830**

(22) International Filing Date: 24 February 2003 (24.02.2003)

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:  
0204310.7 23 February 2002 (23.02.2002) **GB**

(71) Applicant (for all designated States except US):  
**VOITH FABRICS HEIDENHEIM GMBH & CO.**  
**KG.** [DE/DE]; Kurze Strassè 11, 89522 Heidenheim (DE).

(71) Applicant (for MZ only): **SAYERS, Ian, Christison**  
[GB/GB]; 30 Chesterbrook, Ribchester, Lancashire PR3  
3XT (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **KARLSSON, Kjell,**  
**Anders** [SE/SE]; Dalavägen 11, S-702 17 Örebro (SE). **LI-**  
**DAR, Väinö, Per-Ola** [SE/SE]; Hästhagsvägen 8, S-640  
10 Högsjö (SE).

(74) Agents: **GOODWIN, Mark et al.**; Wilson, Gunn M'Caw,  
41-51 Royal Exchange, Cross Street, Manchester M2 7BD  
(GB).

(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,  
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,  
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,  
SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC,  
VN, YU, ZA, ZM, ZW.

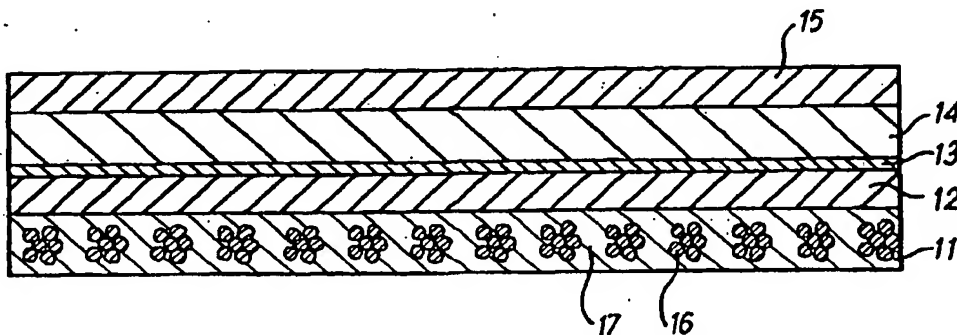
(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI,  
SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN,  
GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **PAPER MACHINE BELT**



(57) Abstract: A papermachine belt comprises a layer for providing strength in the cross-machine direction ("the cd supporting layer") and additional layers of polymeric material. One of the layers of polymeric material is provided on one side of the cd supporting layer and another of the layers of polymeric material is provided on the observe side of the cd supporting layer. The amount and type of polymeric material provided on either side of the cd supporting layer is selected so as to eliminate edge curl.

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## PAPERMACHINE BELT

The present invention relates to papermachine process belts and particularly, but not exclusively, to belts for transferring and/or smoothing the paper web within, to and/or from the press section of a papermachine.

5        Transfer belts are used for carrying a paper web through a portion of a papermachine so as to eliminate open draws in which the paper web is unsupported and is thus likely to break. When the web breaks the papermachine must be shut down and consequently this constitutes a serious problem to the papermaker. Such transfer belts tend to have a smooth surface which can aid  
10    smoothing of the paper sheet and provide an extremely uniform pressure distribution in the nip with no basecloth mark. The surface should nevertheless provide for easy sheet release. Furthermore, the belt in use should be water impermeable.

      In EP 1127976 a transfer belt comprises a base support having a layer of  
15    thermoplastic material formed thereon. A batt of fibrous material is located on top of this thermoplastic material. The whole structure is then heated in order to allow the thermoplastic material to migrate to the surface. It is common for transfer belts, such as that described in EP 1127976, to suffer from the drawback of edge curl, i.e. inward curling of the edges of the belt. In severe cases this can  
20    lead to the belt folding over which would, at the very least, mark the roller and cause misalignment and damage to the paper sheet.

      Edge curl is caused by differential contraction properties associated with different materials used within the belt structure, as well as various finishing processes. For example, polyurethane film has a much greater shrinkage than the

yarns of a woven structure and so when a film layer attached to a woven base cloth is partially melted, on cooling, it exerts a contractive force on the base structure, resulting in curling.

The present invention has been made from a consideration of this.

5       According to the present invention there is provided a papermachine belt comprising a papermachine belt comprising a layer for providing strength in the cross-machine direction (hereinafter "the cd supporting layer") and two or more additional layers, wherein at least two of said additional layers consist of a polymeric material and wherein at least one of said layers of polymeric material is provided on one side of the cd supporting layer and at least another of said layers of polymeric material is provided on the obverse side of the cd supporting layer.

For example, surprisingly, the provision of a similar mass of polymeric material on either side, i.e. face of the cd supporting layer, which gives the cross-machine strength and rigidity for the belt, results in a balancing effect insofar as the anticipated differential thermal shrinkage properties of the polymeric layers are concerned, so as to yield a belt with no edge curl. Different polymeric materials having different shrinkages may be used in combination, so that further to exposure to thermal energy, the shrinkage forces are balanced, so eliminating edge curl.

20       Ideally at least one layer of polymeric material is provided on the paper facing surface of the belt. The polymeric material is ideally provided as a film, but may, for example, alternatively be provided as sinterable material or as a fibrous material. This layer, in the finished product, is ideally water-impermeable.

Preferably some, and ideally all, of the layers of polymeric material preferably have a Shore hardness in the range from 30A to 75D, and ideally have a hardness of substantially 90 Shore A. Ideally, the weight of each polymeric layer is approximately  $400\text{g/m}^2$ . The thickness of each layer of polymeric material is ideally in the range from 0.4 to 1.0mm. The preferred polymeric material is a thermoplastic polymer, such as a polyether based polyurethane, ideally in film form.

Polymeric materials having different colours may be used. For example, if a laminate of two polymeric materials were to be used in which the individual lamina had different colours then as the outer layer wears away the lower layer (having a different colour) would become exposed. This would act as wear indicator. Alternatively, the use of differently coloured polymeric materials might be useful for providing a guiding bar mark across the belt width. Pigments and additives may be included in the polymeric material as desired, such as photochromic pigments and/or ultra-violet fluorescent material.

The supporting layer providing the cross-machine strength is ideally a structure made up of a plurality of cross-machine direction yarns, preferably multi-strand (e.g. multifilament or cabled) yarns, which are laid in close proximity to one another. However, in order to give ease of handling, the cross-machine direction yarns may preferably be loosely bound together with very fine machine-direction yarns. For example, the machine-direction yarn diameter may be in the order of 0.1mm and selected for pliability, compared to the stiff cross-machine direction yarn with a diameter of approximately 0.5mm. The ratio of the mass of the cross-machine direction yarns to machine direction yarns is ideally

substantially at least 160:1. The whole layer providing cross-machine stability has a weight of approximately  $200\text{g/m}^2$ . Ideally this layer includes approximately 9 to 15 cross-machine direction yarns/cm, preferably 12 cross-machine direction yarns/cm.

5        It was found that this quasi-nonwoven cd supporting layer embedded between the layers of thermoplastic polymer, further to heat treatment and calendering, results in a laminated product with much improved macro-level pressure uniformity, due to the fact that there was far less chance of sheet marking, as is typical of substrates containing woven substrates with pronounced  
10    warp knuckles.

      In addition, the belt preferably comprises a machine direction (md) supporting layer to be needled on the roll side of the structure, to provide strength and md stability. This md supporting layer may be in the form of a woven, knitted or moulded perforated membrane, for example of the type described in EP  
15    0285376. However, this supporting fabric ideally comprises an array of strong, stable, spirally wound, machine direction yarns. Layers of fibrous batt can also be needled in order to hold the said yarns in position and to provide a coherent structure. The provision of additional batt on the roll side can also offer better wear resistance. In a preferred embodiment, the machine roll side layer is made  
20    up of spirally wound, machine direction, 0.2 mm/2 ply/3 cabled, polyamide yarns, with approximately 7 to 12 yarns/cm. There is approximately  $50 - 800\text{ g/m}^2$  of polyamide batt fibre in the range of 3 to 67 dtex needled thereon. This whole layer preferably has a weight in the range from 450 to  $480\text{g/m}^2$ .

The spirally wound layer of md yarns with batt needled thereon is the preferred supporting substrate for a number of reasons. Firstly, marking due to cd/md yarn cross-over knuckles, as exist in woven substrates, is eliminated. Secondly, shrinkage upon heat-setting of a fabric generally takes place mainly in  
5 the cross machine direction because the machine direction length is held constant between the two rollers on the stretcher. The spirally wound layer is more yielding than a woven structure in the cd, due to there being only batt between the md yarns, which does not prevent the yarns from bunching together in order to conform to the shrinkage requirements of the thermoplastic film located thereon.

10 It is possible to use, in place of the cd and md supporting layers, a single base structure, which acts as both a cd and md supporting layer. This may be, for example, a woven material or possibly a nonwoven or a film. A preferred example is a double layer woven fabric with polymeric material on both faces. Examples include laminates and integrally woven multiple layer bases. Yarn sizes  
15 would typically be from 0.2mm to 0.6mm diameter.

A layer of batt fibre, preferably in the range from 3.1 to 44 dtex, would ideally be needled to this woven base structure.

The structure as a whole may additionally comprise separate layers of batt fibres. The batt is needled to the any other layers so as to mechanically inter-lock  
20 them together, as well as providing a higher level of pressure distribution. The batt used preferably has a weight in the range from 50 to 800g/m<sup>2</sup> and ideally in the order of 300g/m<sup>2</sup>. The total belt thickness is normally between 2.4 and 3.2mm, with an average weight of between 2600 and 3300g/m<sup>2</sup>.

The preferred structure of the invention comprises at least five main layers, which working from bottom to top include:-

- 1) an md supporting structure,
- 2) thermoplastic film or films,
- 5 3) a cd supporting structure,
- 4) a fibrous batt, and
- 5) further thermoplastic film or films, ideally wherein the mass of thermoplastic material of layer (2) is substantially the same as that in layer (5).

10 The belt is preferably made endless, but could feasibly include a seam.

The whole structure is consolidated through needling at various stages during the manufacturing process. As a result of the needling stage, the surface is not entirely smooth as there are around 1 to 200 batt fibres per square cm, and preferably 10 - 100 batt fibres per square cm protruding through to, and in some  
15 instances standing proud of, the polymer surface. These provide for good sheet release. The fibres might take the form of loops, that is the middle of the fibre has been pushed through with both ends still remaining locked within the structure. If desired, the protruding fibres may be removed.

Further to the needling process, the entire structure is then exposed to  
20 sufficient thermal energy to cause the lower melt point, thermoplastic, polymeric film to melt. This melted polymer bonds the structure together, embedding the cd supporting layer and part of the batt in a matrix of molten polymer and forms a very smooth and well defined impermeable surface, which is resistant to delamination. The belt is then smoothed with a cold polished cylinder. There is no

need to grind the finished product, which is advantageous because this is extremely difficult to achieve in the case of low melt polymeric elastomers.

In an alternative preferred structure the order of layers "1" and "2" hereinbefore described is swapped around, such that the structure comprises at least five main layers, which working from bottom to top include:-

- 1) thermoplastic film or films,
- 2) a supporting structure providing machine-direction stability,
- 3) a structure providing cross-machine stability,
- 4) a fibrous batt, and
- 10 5) further thermoplastic film or films, wherein the mass of thermoplastic material of layer (1) is preferably substantially the same as that in layer (5) to minimise edge-curl.

Such an arrangement helps prevent batt loss and assists with ease of cleaning.

15 In order that the present invention may be more readily understood, a specific embodiment thereof will now be described by way of example only with reference to the accompanying drawing in which:-

Fig.1 is a diagrammatic cross-section through a transfer smoothing belt in accordance with the present invention.

20 Referring to fig.1 a transfer and smoothing belt 10 for use in the press section of a papermachine consists of an endless loop having five layers 11-15.

The supporting layer 11, consists of spirally wound machine direction yarns 16 into which batt has been needled to hold the yarns 16 in position. In this

embodiment the machine direction yarns consist of three pairs of yarns twisted together.

The second layer 12, located on layer 11, itself comprises two individual layers of thermoplastic polyurethane each having a weight of  $400\text{g/m}^2$  and being  
5 0.4mm thick. On heating these two polyurethane layers, a single homogeneous layer is formed which bonds and partially impregnates the mid supporting fabric 11 and the adjacent upper cd supporting layer 13.

Layer 13 consists of a quasi non-woven structure made up of multifilament, cross-machine direction yarns and extremely fine machine direction  
10 yarns, for loosely holding the cross-machine direction yarns in position. This layer has a weight of approximately  $195\text{g/m}^2$ . The mass of material ratio of cross-machine direction yarns to machine direction yarns is approximately 160:1. This layer provides cross-machine direction strength and rigidity.

A layer 14 of batt is located above the cross-machine direction supporting  
15 structure 13 to facilitate inter-locking of the various layers by needling. The batt material preferably has a weight in the order of  $300\text{g/m}^2$ .

The final layer 15 of thermoplastic material is ideally identical to the inner thermoplastic material layer 12. On heating, the constituent polyurethane layers flow and bond the structure together, embedding the top cd supporting layer and  
20 part of the batt 14, in a polymeric matrix, to form a single homogenous layer. The belt is cured at a surface temperature of approximately  $200^\circ\text{C}$  with a dwell time of 5 minutes. It is then calendered at 1 to 40 KN/m at a temperature of less than  $200^\circ\text{C}$ .

Surprisingly, by embedding a cd supporting structure between layers of melted thermoplastic polymeric material, a balance of contractive forces is achieved. That is, the relatively stiff, high bending modulus cross-machine direction orientated yarns, placed in a position relatively near to the top plane of the fabric; between the melted polymeric material, can successfully balance the contractive forces of the melted polymeric material, so as to yield a belt with no edge curl.

From recent in-house trials on a pilot machine it has been found that the belt described above gives excellent transfer at 2000m/min and the surface has been found, using Martindale Abrasion testing methods, to exhibit good abrasion resistance. In particular the belt was found not to suffer from edge curl.

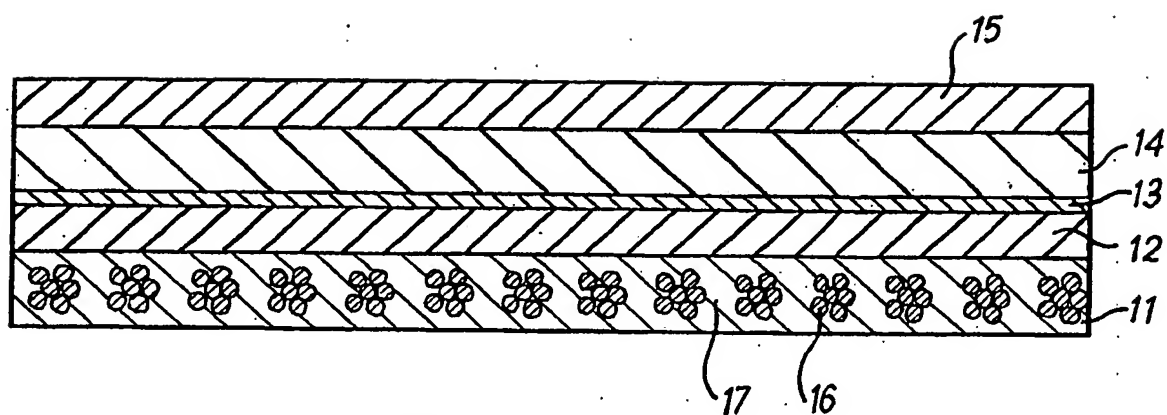
It is to be understood that the above described embodiment is by way of illustration only. Many modifications and variations are possible.

**CLAIMS**

1. A papermachine belt comprising a layer for providing strength in the cross-machine direction (hereinafter "the cd supporting layer") and two or more additional layers, wherein at least two of said additional layers consist of a  
5 polymeric material and wherein at least one of said layers of polymeric material is provided on one side of the cd supporting layer and at least another of said layers of polymeric material is provided on the obverse side of the cd supporting layer.
2. A papermachine belt as claimed in claim 1, wherein the amount and type of polymeric material is selected so as to eliminate edge curl.
- 10 3. A papermachine belt as claimed in claim 1 or claim 2, wherein the mass of polymeric material provided on said one side of the cd supporting layer is substantially the same as that provided on the obverse side of the cd supporting layer.
4. A papermachine belt as claimed in claim 1 or claim 2, wherein at least two  
15 of said layers of the polymeric material comprise different polymers.
5. A papermachine belt as claimed in any preceding claim, wherein at least one layer of polymeric material is provided on the surface of the belt operative to support a paper web.
6. A papermachine belt as claimed in claim 5, wherein the layer of polymeric  
20 material, provided on the surface of the belt operative to support a paper web, is water-impermeable.
7. A papermachine belt as claimed in any preceding claim, wherein at least some of the layers of polymeric material have a Shore hardness in the range from 30A to 75D.

8. A papermachine belt as claimed in any preceding claim, wherein the thickness of cd polymeric layer is in the range from 0.4 to 1.0mm.
9. A papermachine belt as claimed in any preceding claim, wherein at least one of the layers of polymeric material comprises a thermoplastic material.
- 5 10. A papermachine belt as claimed in claim 9, wherein the thermoplastic material is a polyether-based polyurethane.
11. A papermachine belt as claimed in any preceding claim, wherein the cd supporting layer exhibits different shrinkage to said layers of polymeric material.
12. A papermachine belt as claimed in any preceding claim, wherein at least  
10 two of the layers of polymeric material have different colours.
13. A papermachine belt as claimed in any preceding claim, wherein the cd supporting layer comprises a plurality of multi-strand cross-machine direction yarns.
14. A papermachine belt as claimed in any preceding claim, wherein the belt  
15 further comprises a machine direction supporting layer.
15. A papermachine belt as claimed in claim 14, wherein the machine direction supporting layer comprises an array of spirally wound machine direction yarns.
16. A papermachine belt as claimed in any preceding claim, wherein the belt  
20 further comprises at least one layer of batt.

1/1



**FIG. 1**

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 03/00830

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 D21F7/08

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 4 643 916 A (KIUCHI MASAO) 17 February 1987 (1987-02-17) the whole document	1-6, 9-11, 13
X	EP 1 096 065 A (ICHIKAWA CO LTD) 2 May 2001 (2001-05-02)  paragraph '0031! - paragraph '0036!; figures 8-10  -/-	1, 5, 8-10, 13, 14

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

5 June 2003

Date of mailing of the international search report

20/06/2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

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## INTERNATIONAL SEARCH REPORT

Internat<sup>l</sup> Application No  
PCT/GB 03/00830

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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